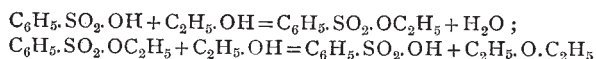


This mode of preparation of ethyl ether and its homologues from alcohols by means of sulphonic acids may therefore be very advantageously substituted for the ordinary process now in use. It may be carried on in a perfectly continuous manner, employing the same quantity of the sulphonic acid for weeks, in open vessels and upon any scale. There would appear to be practically no limit to the amount of alcohol which any definite amount of sulphonic acid is capable of converting into ether. Prof. Krafft has actually followed the process with benzene sulphonic acid until one hundred times its weight of alcohol had been so converted, and the residual sulphonic acid appeared as capable of bringing about the reaction, and as free from products of decomposition, as at first.

The reaction in the case of benzene sulphonic acid can readily be proved to occur in the two stages indicated in the following equations:—



For if the process is arrested at any time and the liquid in the distilling vessel is poured, when cool, into water, the ethyl ether of benzene sulphonic acid, $\text{C}_6\text{H}_5\text{SO}_2\text{OC}_2\text{H}_5$, immediately separates in the form of a difficultly soluble heavy oil, which after separation is found to boil at 156° under 15 m.m. pressure, which temperature has previously been given by other observers as the boiling-point of the compound.

The benzene sulphonic acid may be replaced by benzene disulphonic acid, para-toluene sulphonic acid, β -naphthalene sulphonic acid, or any stable sulphonic acid or its esters.

As a laboratory or lecture experiment this new process of etherification may be easily carried out in the following manner:—The sulphonic acid, about 80–120 grams in quantity, is conveniently placed in a strong glass tube, 25–30 centimetres high and 5 centimetres wide, closed at one end. The open end is stoppered with a well-fitting ordinary cork bored with three holes, through one of which a thermometer is inserted, through another the tube leading to the condenser, and through the third the stem of a dropping funnel. The benzene sulphonic acid is first melted and then heated to about 135 – 145° with the thermometer in the liquid. Alcohol is then allowed to emerge into the hot liquid from the dropping funnel, whose stem is made to end in a fine opening only about an inch from the bottom of the reaction cylinder. The supply of alcohol is maintained constant at a convenient rate from a reservoir whose delivery tube passes air-tight through a cork in the neck of the dropping funnel. The two layers of ether and water then rapidly collect in the cooled receiver into which the tube of the condenser passes.

The process lends itself equally well to the preparation of mixed ethers. For instance, if a mixture of methyl and propyl alcohol are allowed to pass through a layer of a sulphonic acid, β -naphthalene sulphonic acid was used in the actual experiment made, at a temperature of 122 – 126° , the product consists largely of methyl propyl ether. This mixed ether, which has previously been found so difficult to obtain, and which is important as being isomeric with ethyl ether, can readily be obtained pure by fractional distillation of the product, when it is found to boil constantly at 37° . Similarly, di-methyl and di-propyl ether may be readily prepared from the corresponding alcohols. Isobutyl ether may also be obtained with ease from isobutyl alcohol by use of a sulphonic acid, a reaction which it has hitherto not been found possible to carry out by means of sulphuric acid.

A. E. TUTTON.

THE PROGRESS OF TECHNICAL EDUCATION.

SINCE the passing of the Technical Instruction Acts in 1889 and 1891, authorising County Councils to devote the funds accruing under the local taxation (Customs and Excise Act, 1890) to educational purposes, considerable progress has been made both as regards the number of authorities who have availed themselves of the provisions of the Act, and also in respect to the proper disposal of the funds. From the last report of the National Association for the Promotion of Technical and Secondary Education it appears that out of a total of 126 local authorities in England and Wales, 114 are now giving the whole, and twelve are giving part of the grant to educational

purposes, and, estimating the total amount distributed at £750,000, no less than £604,000 is spent to this end. These figures show that the work of technical instruction is firmly established, and it only needs to be organised and consolidated to become a very important factor in our educational system.

It seems desirable, now that the scheme has had sufficient time to crystallise into shape, to put on record some of the experiences of Technical Instruction Committees, as set forth in reports to various County Councils. By this means it is possible to give an idea of the developments which are most likely to end in good results. No attempt is made in the following to discuss all the reports, for such a course would be beyond the limits of this paper. A few reports have been selected, and from them extracts have been taken which are likely to be of use for future procedure.

For convenience we begin with the northern counties. The Northumberland Committee reports that—"The average attendance at the science classes was not quite as satisfactory as might have been anticipated. It is notable, moreover, that the centres where the attendance was smallest were not always situated in sparsely populated districts. On the contrary, in more than one fairly populated district, where educational work of a similar character has been carried on for some years, and where a general and ready appreciation of the advantages offered might reasonably be expected, the results were disappointing. In several instances the teachers experienced difficulty on account of the lack or diversity of the previous training of the students, and it is to be hoped that the more general establishment of night schools and continuation classes will, in the course of time, prepare the ground for the work of the special technical instructors."

In thus expressing the need for more schools to prepare the ground for technical instruction, the committee shows its good sense. Elementary science is the best foundation of a technical education, and to attempt to infuse a knowledge of technicalities into the minds of the young mechanics of this country without such a preliminary grounding, is to court failure. The action of the Department of Science and Art, in withdrawing grants for second-class certificates, was taken in order to force the Technical Instruction Committees to provide the necessary elementary instruction. Unfortunately, however, some committees have not yet realised their duty in this matter, so between them and the Department many classes in elementary science have fallen to the ground.

One of the greatest needs experienced by Northumberland is for a good secondary school. To quote the report: "The facilities for secondary education in Northumberland are in certain parts of the county entirely absent, and where they do exist appear to be in many cases inadequate, inefficiently equipped, and having no relation to the established agencies for elementary and higher education. In the south-west of the county there is no secondary school of any description, and the lad who gains a scholarship has no choice between Newcastle and Carlisle. . . . Of the schools of a secondary character already in existence in the county, in only one or two cases is there any attempt to provide systematic instruction in science, and in no case is there, outside Newcastle, laboratory accommodation for practical work in chemistry or physics."

This is a very regrettable state of things, and much progress cannot be made until it is altered. A good secondary school should be established at every large centre of population. There are, however, numerous large districts not so favoured. For example, the Technical Instruction Committee of the West Riding of Yorkshire, which is without doubt doing as good work as any committee in the country, reports that in the Todmorden district, with a population of over forty thousand, the nearest available secondary schools are at Halifax, more than twelve miles away, and there are many districts in other counties far worse off. Clearly a portion of the sums now spent in the railway fares of holders of scholarships would be better expended in the establishment of secondary schools in the required districts, or by increasing the scholarships to the amount necessary to cover the cost of maintenance of the scholar at a residential college. The payment of the West Riding Committee for railway fares during the year covered by the last report amounted to nearly £4000, of which about £3000 was expended under the scholarship scheme. This money would be better spent in subsidising local technical schools, and the committee intends in the future to follow such a course as far as possible.

It has been remarked that the Department of Science and Art is throwing its responsibility to some extent upon the County Councils. The West Riding Committee estimates that by the withdrawal of grants for apparatus and second-class students, an expenditure of more than £3,500 has been shifted to their Yorkshire Council. It is justly complained that "the changes have been carried out without in any way considering the views of the County Council. It is clearly necessary that some distinct understanding should be arrived at as to the spheres to be respectively occupied by County Councils and the several Government departments, including the Education Department, the Science and Art Department, and the Agricultural Department, or it may be found that the funds specially granted to the County Councils for the purpose of technical instruction are being largely absorbed in carrying out the work hitherto devolving upon Government departments."

To some extent, however, the departments referred to are completely justified in their action. Thus, instruction in elementary science can very well be relegated to local authorities, and so leave the Department of Science and Art to foster more advanced work. This brings us to another point, viz. the system of payment by results. Any other system involves the employment of a large staff of inspectors, and the question then arises as to whether the close inspection required ought to be carried on by the County Councils or by Government officials. It is the opinion of many directors of technical instruction that a Government official is in a better and more independent position for doing such work than a county official. Usually the work of inspection done on behalf of most counties is small. In the case of the West Riding Committee a number of inspectors have been appointed, and the grants made to classes, schools, and institutions under its jurisdiction take the form of capitation grants, depending, not upon the instruction given, nor upon the number and size of the classes at each school or institution, but upon the attendance and work of the individual pupils and students. This admirable system is certainly worthy of extended application.

The Union of Lancashire and Cheshire Institutes has done much to promote primary, secondary, and technical education in Lancashire, Cheshire, and North Derbyshire, and to consolidate the various associations that exist in those counties. The Union acts as an examining board, and offers special prizes and exhibitions for the encouragement of science and art. As evidence of the importance of the Union, and the great activity shown in the cause of technical and secondary education, it is sufficient to say that 128 institutes are affiliated to it, with a membership of over 100,000, and upwards of 80,000 students attending evening classes, and at the examinations held this year 10,700 papers were worked. These facts are enough to indicate that the Union has become an important examining authority in Lancashire and Cheshire. It is satisfactory to know, therefore, that the governing council fully recognises the necessity of good teaching and a thorough systematic scheme of education. It is to some extent owing to the existence of this Union that Lancashire ranks among the counties doing the best educational work. Cumberland and Durham are also developing excellent and comprehensive schemes of instruction.

Passing now to the southern counties, we find that Kent has been largely spending its money upon University Extension Lectures. The following extract from a report of one of the lecturers is therefore of interest:—

"Although the last two years' experience in Kent must have convinced all of the great possibilities of technical education in rural districts, yet at present the success is but partial, and the results ephemeral, owing to the isolation and want of continuity of the various educational ventures in process of trial. To achieve real educational results, local classes under local teachers should be formed in each village centre. Laboratory accommodation of a simple and inexpensive nature should be provided, and from time to time a course of lectures by an experienced lecturer might supplement the local class, and serve to arouse general sympathy, interest, and enthusiasm."

"Most emphatically would I urge, with the whole conviction of past experiences, the absolute necessity for practical laboratory instruction as a part of any scheme for the teaching of chemistry. To make technical education a real servant to the national weal, and a sound branch of educational progress, it will be necessary to connect, systematise, and unify the varied educational machinery employed. The successful founding of village laboratories and classes, under capable instructors, will

make it possible for a village lad to place his foot upon the first rung of a ladder that will raise him through urban technical institutes or county colleges to the higher levels of scientific and technical instruction."

"As an extension lecturer, I feel bound to confess that, standing alone face to face with the problem of technical education in rural districts, our present system is doomed to failure unless supported by an adequate system of local teaching, and, as a student of science, I feel convinced of the absolute impossibility of imparting an intelligent group of scientific principles capable of practical application and utility unless such instruction be supplemented by courses of practical and experimental study."

This is a right view to take. The function of the extension lecturer is that of a pioneer in the case of science, whatever it may be with literature. There is no doubt that in the classes held after extension lectures, the lecturer assumes more the part of a teacher by being brought into closer contact with the students, but even then it is doubtful whether he is often regarded as more than a popular exponent of elementary principles.

The Technical Instruction Committee of the Surrey County Council is a very strong one, and its efforts have been attended with a remarkable measure of success. In the tenth report of the committee, however, it is remarked with regard to the science classes: "There is probably no branch of the work more educationally important than this, and in Surrey, as in other counties, it has been found that there is none which meets with more passive opposition from the public, and, perhaps, costs more, in consequence of the entire lack of efficient teachers in the localities themselves." We are afraid that this is very true. That undefinable quantity—the general public—may attend science lectures of which the main features are magic-lantern illustrations, or explosions and pretty experiments; but that is quite a different matter from attending classes requiring close study. We do not for an instant hold that popular science lectures are not productive of good. By their influence the commonality are brought to know something of the poetry of science, and are set thinking about nature's laws and wonders. What we do contend, however, is that such discourses must be regarded as of a recreative character, calculated more to interest and amuse than to give a clear view of the true inwardness of scientific things. The general public wants variety and highly-coloured facts, and a very small proportion indeed are inclined to take upon themselves the drudgery of hard study. Technical Instruction Committees should remember, therefore, that though the attendance at classes may be small in comparison with that at lectures, the students are mostly workers who take up science seriously, and with the full knowledge that many difficulties must be met and overcome. It is upon this class of the community that all schemes of technical instruction depend for their success. As to the second point raised in the above extract, there is little doubt that, in many counties, peripatetic teaching by good teachers, who can be obtained by the payment of a good salary, is preferable to entrusting the instruction to local dabblers in science. This applies chiefly to country districts in which science was almost unheard of before the County Councils began their educational work.

In the last scholarship report of the Surrey Committee, Mr. Macan, the organising secretary, makes a gratuitous remark that can by no means be substantiated. He says: "The subjects which require most attention in the schools appear to be chemistry, heat, and electricity, and masters are reminded that the purely bookish and routine instruction, which serves to gain South Kensington results, is not enough for a scholarship examination." This is a cheap criticism that might well have been omitted. Any teacher who has had experience of the South Kensington examinations knows that great stress is laid upon the practical teaching of the subjects named, and examiners are expressly forbidden to award marks for meaningless phrases such as are given by candidates with mere book knowledge. And we will say further, that any candidate who could pass the elementary examinations in chemistry, heat, or electricity, held by the Department of Science and Art, would come off with flying colours in the scholarship examination of the Surrey County Council. There is not a single question upon these subjects contained in any of the examination papers of the Council but what a departmental examiner at the present time would consider too elementary for South Kensington candidates.

The work of the Berkshire Technical Instruction Committee has been greatly facilitated by the establishment of the University Extension College at Reading. The college possesses good teachers, and, owing to the proximity of Reading to London, and the special relations which the college has to Oxford, the services of specialists can easily be obtained to supplement the teaching of the regular staff. For the sum of about £300 per annum paid to the college, systematic instruction is given to teachers in elementary schools at four centres. The scheme followed provides an excellent graduated course extending over three years, and given by well-qualified instructors. An agricultural department, such as exists at Bangor, Leeds, and Newcastle, has been added to the college, so that it will not be necessary to send students holding agricultural scholarships out of the county for their instruction. The establishment of University Extension colleges at strong centres is certainly an admirable plan, and County Councils would do well to assist in their foundation and adequate equipment.

An important report upon the relation of secondary schools to a county scheme of technical education has been prepared for Southampton county by Mr. Vaughan Cornish, and adopted by the Technical Instruction Committee. The fact is recognised that it is of little use to make provision, by scholarships or otherwise, for the highest forms of technical training unless there are schools which provide such an instruction. Hampshire at present possesses very few schools of this kind, but the committee proposes to assist, by means of capital grants to improve the appliances for teaching, by capitation grants, and by scholarships, the public secondary schools in the county that are able to give an efficient general preparation for an industrial (*i.e.* manufacturing, agricultural, or commercial) career. Something can be said in favour of this scheme, but great care will have to be taken in the selection of the schools, or the funds may be misapplied.

From the report of the Wiltshire Technical Instruction Committee, it appears that that county shows a lower standard of general elementary education than that of almost any county in England. On this account, the majority of the students are not fit recipients of higher or technical education; and the fact that very few technical or secondary schools exist within or in the near neighbourhood of Wiltshire, has rendered the work of the committee most difficult. It has been necessary to create as well as foster a desire for technical education. In this connection the following extract from a letter addressed to Lord Fitzmaurice by Mr. Ashenhurst is of interest:—

"It must be borne in mind that mathematics are the real foundation on which technical knowledge alone can be built up, and I am fully convinced in my own mind that intending students seeking instruction in the different technological subjects, for the teaching to be of any practical use to them, they must of necessity study the above-mentioned subjects. Until such times as classes for the study of the higher branches of arithmetic and mathematics are established, it is almost useless for the committees of different technical schools in the county to expect a large number of students to derive advantage from the various subjects being taught in technology.

"These remarks are based upon the fact that, personally, I have been obliged to teach arithmetic before the students could make the necessary calculations for the branch of textile industry I am now particularly engaged to teach, *viz.* cloth weaving and designing.

"Had such institutions as the Mechanics and Working Men's Institutes, which have been so prevalent in the large towns and villages of the North for this last thirty or forty years, been established in this district, where evening classes could have been held for instruction in elementary subjects, the educational standard of this county would have held its own with that of any other in the United Kingdom."

But though the committee has had to labour under such difficult conditions, and has made some mistakes (which was inevitable, perhaps, under the circumstances) it has worked energetically and well in initiating and fostering technical education in Wiltshire, and it has evolved a system of instruction that ranks in point of excellence even with that of any northern county.

The real object and scope of technical education is thus stated by the Devon County Council:—

"It is not contended that technical education will prove a panacea for all the evils resulting from the depression of trade

and agriculture, or that it will remedy all the difficulties arising from foreign competition. But it is certain, that by due attention and reform in our educational methods, a good deal can be done to remove some of the more serious defects under which our industries are at present carried on.

"Technical education has been described as being not so much a specific subject, or group of subjects, as a *method*. It is concerned with the 'why' and the 'wherefore' and the 'how.' It enables workmen to develop their faculties, to obtain a knowledge of the principles underlying their work, and to get thoroughly practical information with regard to the materials and the tools which they use. It provides a means for the training of the eye and hand, and encourages dexterity, neatness, and order; and while not in any way antagonistic to book learning, it relies to a great extent upon handwork rather than upon headwork. It does not, however, involve the teaching of the practice of a trade or industry, or the drilling of individuals as apprentices would be drilled."

This certainly reads very well, and may be taken as a sign that Devonshire is at last beginning to work on good lines. We notice with some regret, however, that the committee has decided to relegate some of their powers to District Committees. The whole provision of technical instruction is to be in the hands of (1) the County Technical Education Committee; (2) the District Committees, who are responsible to the County Technical Education Committee; and (3) the Local or Parish Committees, who are in turn responsible to the District Committees. The general opinion of those who ought to know is that the system of District Committees or Divisional Committees is a hopeless blunder. Such bodies may be of use for advising purposes, but when money has been allotted to them for distribution, it has generally led to inefficient and extravagant expenditure. It is satisfactory to learn that the instruction in the technical and the science and art schools of Devon is increasing in comprehensiveness, but there is yet much room for improvement. The last report shows that all the schools devote considerable time and energy to art, but few of them take up an adequate number of science subjects.

The committee of the Cheshire County Council does not institute classes, but make grants to various centres to carry out class work. A staff of lecturers is kept engaged in visiting various places, and giving series of lectures on subjects mostly connected with agriculture. Grants are made to grammar schools, and considerable subsidies are given to various bodies for building purposes. In addition to these grants, most of the town councils and local boards in Cheshire tax themselves for technical instruction purposes. The county also possesses a comprehensive scholarship scheme. It seems a pity, however, that the committee does not pay more attention to the teaching of the rudiments of science, instead of concentrating their energies almost entirely upon "bread and cheese" subjects.

Before the Technical Instruction Act came into operation, Shropshire had done very little to foster education of any kind. It is not at all astonishing, therefore, to learn that much of the early work of the Technical Instruction Committee was futile. In 1892 the scheme for agricultural and science scholarships completely failed; six were offered of the former, and ten of the latter, but though the examinations were well advertised, only one candidate entered his name, and he failed to obtain half the total marks adjudged to the papers set. There was also a very limited competition for the exhibitions and scholarships offered this year; indeed, the results have been so unsatisfactory that the committee has rescinded the original scholarship scheme and substituted another. Salop is not alone in this respect, for quite a number of counties have had a difficulty in producing candidates for their scholarships, to their discredit be it said. The committees of these counties will have to work for many years before they bring their charges up to the standard of counties like Yorkshire.

The work of technical instruction carried on in Somerset is based upon broad lines, and is extending. From the outset, however, the task of the committee has been made more difficult by the almost complete absence of fully organised schools of science and art, the absence of any adequate provision for science or technical training in the secondary schools, and the consequent inefficient previous education and training of those who have attended the classes in special technical subjects. It was to be expected in such a case that University Extension lectures should be found a satisfactory means of reaching the adult population, and also of great service in creating an interest

in science and in technical instruction generally. The Somerset committee is laying an excellent foundation on which to erect a permanent and comprehensive system of technical education, but some time must elapse before the structure will be seen and properly appreciated by the county. The following extract shows that the committee realises the importance of instruction in elementary science and mathematics:—

"It is the boys at present at secondary schools who will in time become directors and leaders of industries, agricultural or otherwise, and from whom improvements in our various industries ought to come. The best way to prepare them for their future career, and to equip them for their struggle against foreign competition, is to begin whilst they are still at the secondary schools, and give them a sound general education, including a large proportion of science and mathematics. They will thus learn something of the method of experiment and of the manner in which knowledge is acquired, their powers of observation will be cultivated, and their judgment to some extent trained, and they will learn to see much more clearly than at present the intimate relation between science and their daily life and occupations.

"It seems certain that the only way in which a real appreciation of the value of technical instruction in agriculture can be created is to provide for the coming generation of farmers a sound training of the character indicated. In this connection it may be well to call attention to a statement made by Prof. Fream, in his report on technical education to the Royal Agricultural Society of England, that his own experience, extending over many years, shows that a boy who is 'fairly competent in mathematical studies,' is as a rule very good material to work upon in giving instruction in the principles and practice of agriculture. To mathematics, from this point of view, natural science may unquestionably be added.

"At present it must be admitted that the science teaching in the secondary schools in Somerset has not reached the degree of excellence and thoroughness that is desirable, and in some instances the teaching of mathematics is capable of considerable improvement. There is at present no school in the county at which higher scholarships under the Technical Instruction Acts could fitly be made tenable."

Staffordshire did excellent work in the cause of technical education before the passing of the Technical Instruction Act, and since then it has taken the initiative in many important developments. Both last year and this, a number of teachers in elementary schools received grants towards the expense of a course of manual instruction in wood-work, metal-work, and cardboard-work at Dr. Götz's institute in Leipzig, and most of them are now conducting classes in the county. This system cannot be too highly commended, and is worthy of adoption by every county; for by it new methods of work will be learnt, while the insularity that characterises the British workmen will be removed.

Like many other counties, Oxfordshire has to lament the want of an adequate number of secondary and technical schools. On this account it has been found difficult to arrange for the further education of holders of county scholarships. Notwithstanding these serious defects, however, the committee reports that, taking the county as a whole, secondary and technical instruction is in a state of increased efficiency. In common with other committees, that of Oxfordshire sent in 1892 a number of teachers to attend the summer courses on geology, chemistry, botany, and mechanics, arranged at Oxford by the delegates for the extension of University teaching, and with most satisfactory results. A similar summer course for County Council students was held this year, the subjects and the lecturers being:—Geology, Prof. A. H. Green, F.R.S.; Practical Physics, Rev. F. J. Smith; Hygiene, Dr. C. H. Wade; Chemistry, Mr. J. E. Marsh; Animal and Vegetable Pests of Crops and Stock, Mr. P. Chalmers Mitchell and Mr. J. B. Farmer. The success of these short courses indicates that it may be desirable for counties to grant scholarships which would enable students to reside in University towns during term, and take advantage of the many facilities for study available at these centres of learning.

No reference has yet been made to the county boroughs. This survey would not be complete, however, without a few words on the work done in some cities. Oxford city, for instance, has a very strong Technical Instruction Committee, and the work accomplished during the last session shows a very considerable advance upon that of the previous year.

The city of Liverpool possesses a scheme of technical instruction that connects educational institutions from the elementary schools up to the University by means of scholarships and free studentships, and is thus a true educational ladder. The technical instruction is controlled by a sub-committee of the Liverpool Library Museum and Arts Committee. Before this sub-committee came into power, much of the work of technical instruction previously carried on in the city was supported by voluntary contributions, but these were largely withdrawn as soon as public money became available for the purpose. Owing to the loss of income due to this cause, and that which has resulted from the withdrawal of grants by the Department of Science and Art, and the City and Guilds of London Institute, a large portion of the funds set apart by the Council for purposes of technical instruction has to be used in supplying these deficiencies. But in spite of this, new branches of work have been developed, and in a very short time the whole scheme of the sub-committee will be in successful operation. A nautical college has been established, and from the last report of the head-master, Mr. James Gill, it appears that an astronomical observatory is to be erected in the school-yard, which will serve to create a greater interest in nautical astronomy and the almanac by reference to the aspects of the heavens, revealed by the telescope, and the astronomical methods of measuring time. For completeness of equipment and suitability for the work of technical and scientific nautical instruction, the college compares favourably with any of the same kind in the world.

The borough of Bootle has the distinction of being the first to take advantage of the Local Taxation Fund for technical instruction. The instruction provided in the borough is of the right kind, and should lead to good results.

The first report of the Technical Instruction Committee of Plymouth shows that progress is being made. That the demand for technical instruction is increasing in this borough is evidenced by the fact that though a fine school was opened last year, the building will have to be extended in order to provide the necessary accommodation for students.

It is beyond the scope of this article to refer to the numerous institutes and schools, such as those of Manchester, Birmingham, Bradford, Bristol, and Bolton, that existed before 1889, and made provision for technical instruction. The towns that possess these old-established educational agencies are necessarily far ahead of those that have only recently had the importance of technical instruction thrust upon them. It will have been gathered from the foregoing description that the greatest need felt by newly-constituted authorities is for technical and secondary schools. Not until this want has been supplied, either by subsidising existing schools or building new ones, can many of the County Councils hope to see the fruits of their labours. The policy of withdrawing grants for elementary instruction in science, recently taken by various examining authorities, has been the means of raising the standard of efficiency in counties where science classes have been held for many years. In some counties, however, the committees have not realised that it is their duty to provide elementary scientific instruction; for they are using their funds almost entirely in supplying instruction in industrial "dodges." On the other hand, it is becoming recognised that science students must possess a more extended knowledge of mathematics than they usually have before any great advance can be made. No unbiassed observer can deny that the progress reported up to now has generally been in the right direction. Mistakes have, of course, been made, but the committees are usually not slow in seeing their failings, and rectifying them. In a few years, when the distrust and suspicion which hampers the work in some counties has been broken down, we shall have the nucleus of a system of education such as exists in Germany, France, and Switzerland, and shall begin to reap the benefits that accrue from it. R. A. GREGORY.

SCIENTIFIC SERIALS.

Bulletin of the New York Mathematical Society, vol. iii. No. 2 (November, 1893, New York).—"Lachlan's Modern Pure Geometry" (pp. 33-36) contains a review, by Prof. F. Morley, of Dr. Lachlan's treatise. It mainly points out what the writer considers to be defects in the author's programme, but closes with the hope, since Dr. Lachlan shows so much power in handling his subject, that he will "throw examination